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SPACING OF YOUNG RED PINE

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The most desirable spacing at which to grow red pine (Pinus resinosa) has been the subject of debate among Lake States foresters for many years. Plantations have been established with spacings of 8x8 feet, 6x8 feet, or more frequently 6x6 feet, with very few closer. A study of natural stands should help provide an answer to how densely to grow red pine in plantations.

Most natural stands are understocked and therefore widely spaced but occasionally, due to a combination of circumstances, viz., plentiful seed, a good seedbed, and favorable weather, red pine reproduces abundantly and dense sapling stands develop at an age of 15 or 20 years. Such stands may contain as many as 5,000 trees per acre and in extreme cases up to 20,000 (2, 5). Sapling stands of less than about 2,500 stems per acre appear able to thin themselves, but denser ones are subject to stagnation, according to Kittredge (2). Given time, stands approaching 2,500 trees per acre may thin out naturally, but in any case their diameter growth rate will be retarded. Accordingly, thinning of dense sapling stands may be a necessity for optimum stand development. Under present market conditions in the Lake States, such thinnings can be made only with a cash outlay since the products obtained will not pay the cost of the operation. Where a fuelwood market exists, part of the cost of early thinning may be met. Moreover, as the market for small posts improves, early thinning may be possible without any expense whatever and perhaps even at a small profit.

In an experiment at the Cloquet Forest Experiment Station, started in 1927, Schantz-Hansen (5) established 1/10-acre thinning plots in a 15-year-old red pine stand. These plots were thinned to spacings of approximately 4x4, 6x6[2], 7x7, and 9x9 feet from densities of 13,000 to 20,000 trees per acre. The plots classify in the lower portion of the 50-foot site index and the upper portion of the 40-foot site index. During 15 years after thinning, there was little loss of trees on the thinned plots but natural competition on the check area had taken a rather heavy toll. Even so, the check plot still had 8,480 trees per acre which averaged only 2.32 inches d.b.h. in 1942. Thinning may have increased height growth slightly, but acceleration in diameter growth was quite marked. The greatest response was in the 9x9-foot plot and next largest in the 7x7-foot plot. The average d.b.h. of trees on all plots having spacings 6x6 feet or wider did not vary greatly, however.

1/ Maintained at University Farm, St. Paul, Minnesota, in cooperation with the University of Minnesota.

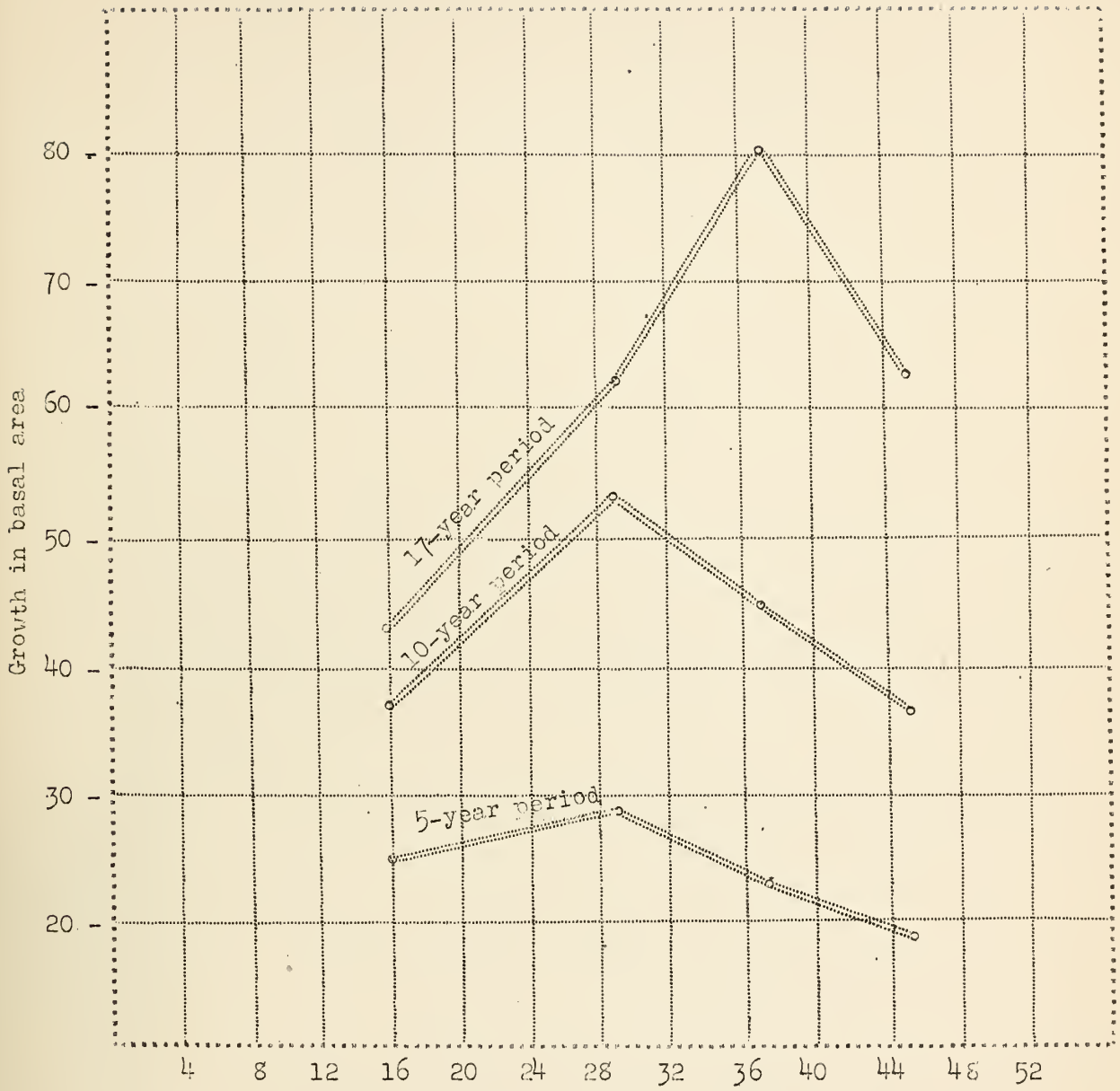
2/ In commenting on this article by Schantz-Hansen, H. B. Wales points out in the JOURNAL OF FORESTRY for December, 1946, that the 6x6-foot spacing was actually 5-1/3 x 5-1/3 feet.

A thinning experiment initiated in 1927 in 23-year-old red pine on the Chippewa National Forest in northern Minnesota sheds additional light on thinning of dense sapling stands. These plots, like those at Cloquet just described, classify in the lower portion of the 50-foot site index and in the upper portion of the 40-foot. Although the plots are small, ranging from one-tenth to two-tenths of an acre in size, and were damaged by glaze in 1940, records have been taken on their behavior over quite a number of years so the results should be fairly reliable.

At the time of thinning, the stand supported from 2,800 to 5,600 saplings per acre from 1 to 2 inches in diameter. The plots were thinned to approximate spacings of 6, 8, and 10 feet respectively, and one plot was left untouched for comparison. Table 1 gives the precise spacings in 1927 and in 1944. The growth and mortality over a 17-year period are shown in table 2. Analysis of the growth by periods (1927 to 1937 and 1938 to 1944) brings out the fact that growth in cubic feet in plots having wider spacings is now increasing whereas that on the 6-foot spacing (now 7.2x7.2 feet) and check plot (now 4.6x4.6 feet) is declining rapidly. The accompanying chart shows a similar trend for basal area. This decrease in growth rate in the more densely stocked plots could, no doubt, be changed by a commercial thinning for pulpwood which could now be made at a profit. The check plot still has the greatest volume both in cords and in cubic feet, but is on slightly better site than the others. The trees on the check area are undergoing natural pruning and the plot is rapidly thinning itself. The thinned plots have lost comparatively few trees except for those broken by the glaze of 1940.

The heavier thinnings have considerably stimulated diameter growth. The 8- and 10-foot plots have many more trees of larger diameter (table 3) than the 6-foot plot and the check plot. The 10-foot spacing, for example, has 47 trees per acre in the 8-inch d.b.h. class of suitable size for small telephone poles; the 8-foot spacing has 10 trees per acre in the same size class, but there are no trees as large in either the 6-foot plot or the check area. The 8- and 10-foot spacings have suffered less from glaze than closer ones. Mulloy (3), in studies of thinnings in young red pine plantations in Canada, also observes that early thinning reduces damage from ice storms because the thinned trees are more sturdy. In these Canadian studies where the plots were on very good site, thinning 24-year-old plantations containing about 1,000 trees per acre to spacings slightly more than 8x8 feet greatly stimulated diameter growth. For special products such as poles, it is desirable to strive for fairly open-spaced stands. Such spacing increases taper, an added advantage in pole production (1). On the basis of the data given here and results elsewhere, the conclusion is that early thinnings can successfully be used to shorten the rotation age when merchantable material can be produced.

Heavy thinning, however, is done at the expense of quality when the timber is used for sawlogs. For best quality, pine timber should have steady, even growth, and the rings should not be too wide (4). Such timber cannot be grown in open stands. In the wider spacings in the Chippewa plots, the limbs are heavier and are lower down on the boles than where the spacing is closer. The height to the first green limb varies from 13 feet on the 10-foot spacing to 17 feet on the check area. The diameter of the average live limb in the lowest 8 feet of crown ranges from .82 inch on the unthinned plot to 1.29 inch on the most open area, with many limbs on the latter being as large as 2 inches in diameter. The open-spaced trees, especially those on the 10x10-foot plot, now need artificial pruning if they are to produce saw timber of good quality but probably not for poles and some other products such as piling where knots are



Spacing--Percent of dominant height immediately after thinning.

Table 1.- Number of trees, basal area, and volume per acre of thinned red pine, 1927 and 1944

Average spacing		Trees		Basal area		Volume				Ht. of ave. dominant tree	
1927	1944 1/	1927	1944	1927	1944	1927 2/	1944 2/	1927 3/	1944 3/	1927	1944
Feet	Feet	No.	No.	Sq.ft.	Sq.ft.	Cu.ft.	Cu.ft.	Cords	Cords	Feet	Feet
9.9	10.7	445	379	19.9	83.4	202	1,247	....	16.3	22	38
7.8	8.1	710	660	27.3	107.2	267	1,571	....	20.3	21	37.5
5.9	7.2	1,254	837	32.4	99.6	294	1,405	....	17.4	20	36
3.6	4.6	3,360	2,080	108.1	151.9	1,104	2,379	....	24.4	23	41

1/ Wider spacing in 1944 is due to mortality, mostly caused by 1940 glaze.

2/ Total peeled volume including stump and top.

3/ Unpeeled to a 3-inch top, i.b.

Table 2.- Growth and mortality per acre of thinned red pine during 17-year period

1927 Spacing	Net growth 1927-1944			Mortality 1927-1944			
	Basal area	Volume		Trees	Basal area	Volume	
Feet	Sq.ft.	Cu.ft.1/	Cords2/	No.	Sq.ft.	Cu.ft.3/	Cords
10	63.5	1,045	16.3	66	4.3	48	.4
8	79.9	1,304	20.3	50	3.6	42	.2
6	67.2	1,111	17.4	417	20.9	252	.8
Check	43.8	1,275	24.4	1,280	31.2	387	2.1

1/ Total peeled volume including stump and top.

2/ Unpeeled to a 3-inch top, i.b.

3/ Of this mortality, the 1940 glaze accounted for 85, 81, 97, and 70 percent respectively on the 10-foot, 8-foot, 6-foot, and check plots.

Table 3.- Number of trees per acre in 1944, 7 inches d.b.h. and larger by degrees of thinning

1927 Spacing	Number of trees per acre (1944)		
	7 inches d.b.h.	8 inches d.b.h.	Both
Feet	Number	Number	Number
10x10	109	47	156
8x8	160	10	170
6x6	15	...	15
Check	30	...	30

less objectionable. A further disadvantage of the 10x10-foot thinning is that the additional light has encouraged the growth of brush and grass which will add to reproduction problems in the future. Encroachment of vegetation is not very noticeable in the 8x8-foot or lighter thinnings. The 6x6 plot (now actually 7.2 feet x 7.2 feet) shows about the best all-around results. Unless it is necessary to force diameter growth to develop special products, there would seem to be no need of making a cash outlay for thinning sapling stands to densities less than 6x6 feet on average sites. By the time stands growing at a 6x6-foot spacing begin to tighten up too much, a light pulpwood thinning will again provide sufficient growing space for good stand development.

As an aid to thinning practice, Wilson (6) advocates the use of a numerical expression of stocking in terms of height. He states that height has the virtue of combining the components of age and site in one measurement, a decided advantage to any index. For the Chippewa plots, the spacings expressed in percent of average height of dominant trees are as follows:

Plot	1927	1944
10x10	45	28
8x8	37	22
6x6	29	20
Check	16	11

Taking the 6x6-foot plot as an example, the thinning to 29 percent of height in 1927 probably represented too wide a spacing the first few years after treatment. The same stand in 1944, however, spaced at 20 percent of height has approached the time for a pulpwood thinning. These figures show the desirability of aiming at spacings of about one-fourth to one-fifth of height for stands 20 to 40 years old. For older stands, it is believed the figure should be a little less than one-fifth the average dominant height. This rule is most easy to apply. Such spacing guides are very useful, but in actual practice, precise spacings should not be the main objective. Instead, every effort should be made to leave the most promising trees and eliminate poor ones even though they stand at the right spacing.

As a general objective, any noncommercial thinning should reduce the number of stems to the maximum that can be carried with reasonably good growth until a commercial thinning can be made. The most desirable spacing will depend on potential markets and on site quality. For average sites in Minnesota, 800 to 1,000 stems per acre (or a spacing about 7x7 feet) seem to represent desirable stocking at the time when the first commercial thinning for pulpwood is possible. On better sites, the number should be less, since better growing conditions permit the trees to make faster growth and fill up the openings more quickly. On poorer sites, more trees should be retained in order to make better use of the available space.

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